

First record of basket stars *Astrocyclus caecilia* (Lütken, 1856) and *Astrophyton muricatum* (Lamarck, 1816) (Echinodermata, Ophiuroidea, Euryalida) for the state of Rio Grande do Norte, northeastern Brazil

Anne Isabelley Gondim¹, Thelma Lúcia Pereira Dias² and Martin Lindsey Christoffersen¹

¹ Universidade Federal da Paraíba, Programa de Pós-Graduação em Ciências Biológicas, Departamento de Sistemática e Ecologia, Campus I, Laboratório de Invertebrados Paulo Young, Cidade Universitária, CEP 58051-900, João Pessoa, PB, Brazil

² Universidade Estadual da Paraíba, Departamento de Biologia, Campus I, Laboratório de Biologia Marinha, CCBS, Rua Baraúnas, 351, Bairro Universitário, CEP 58429-500, Campina Grande, PB, Brazil

* Corresponding author. E-mail: anneisabelley@yahoo.com.br

Abstract: This paper reports the first record of *Astrocyclus caecilia* for northeastern Brazil and *Astrophyton muricatum* for the state of Rio Grande do Norte. The studied specimens were captured accidentally by a fisherman using a fishing rod at a depth below 100 m over the continental shelf of the state of Rio Grande do Norte. Such accidental captures stress our meager knowledge on our fauna from the outer margin of the continental shelf in northeastern Brazil. With these records we fill a gap in the known distribution of those species.

Key words: ophiurans, Gorgonocephalidae, taxonomy, northeastern Brazil

Along the coast of the North and Northeast regions of Brazil our knowledge of the fauna below 20 m is still limited. Particularly the outer margin of the continental shelf (below the depth contour of 50 m) and the continental slope are poorly known in this respect (Migotto and Tiago 1999). Notwithstanding, some incipient initiatives have been taken along the last decades focusing on the characterization of the deep-water fauna in northeastern Brazil. We highlight the program REVIZEE Score N/NE (Programa de Avaliação do Potencial Sustentável de Recursos Vivos na Zona Econômica Exclusiva – REVIZEE) and the Programa de Caracterização e Monitoramento Ambiental da Bacia Potiguar, conducted by PETROBRAS in the Potiguar Basin (State of Rio Grande do Norte).

Ophiuran basket stars are common animals from deeper waters, being commonly found in association with biological substrates, mainly octocorals (Baker 1980). The order Euryalida (commonly known as basket stars or snake stars) is composed by three families (Euryalidae Gray, 1840, Gorgonocephalidae Ljungman, 1867 and Asteronychidae Verrill, 1899) and 181 species (Stöhr *et al.* 2012). Gorgonocephalidae is monophyletic (Okanishi *et al.*

2011), being characterized morphologically by a usually tuberculate skin, as well as by simple or branching arms having rows of hooks on their dorsal surface (Ljungman 1867; Verrill 1899a, 1899b), spiniform teeth, and gonads restricted to the disk (Okanishi *et al.* 2011). The family is known worldwide, being distributed from shallow waters down to more than 1000 m. It may be found associated with biological substrates (gorgonians, stony corals, fire corals, and sponges) and on rocky substrates (Hendler *et al.* 1995).

In Brazil the family Gorgonocephalidae is represented by six species: *Gorgonocephalus chilensis* (Philippi, 1858), *Astrophyton muricatum* (Lamarck, 1816), *Asteroporpa* (*Asteroporpa*) *annulata* Örsted & Lütken in Lütken, 1856, *Astrochele lymani* Verrill, 1878, *Astrocyclus caecilia* (Lütken, 1856), and *Astrogomphus vallatus* Lyman, 1869.

This work reports the first records of *Astrocyclus caecilia* from Northeast Brazil and *Astrophyton muricatum* from the state of Rio Grande do Norte. The present study was based on three specimens captured by a fisherman using a hook and line. They came from the continental shelf about 40 km offshore of Macau city, along the northern coast of Rio Grande do Norte State, northeastern Brazil, (04°42'09.9" S, 036°28'08.2" W to 04°47'56.47" S, 036°27'33.59" W) at a depth of approximately 120 to 130 m.

Species identifications were based on the descriptions of Tommasi (1970), Hendler *et al.* (1995), and Laguarda-Figueras *et al.* (2009). The disk diameter (dd) was measured using a digital EDC 6" caliper, and the specimens were photographed using a Canon G9 10MP and a Canon A640 10MP digital camera coupled to a Nikon SMZ800 stereomicroscope and to an Olympus BX41 microscope.

The specimens examined were fixed in 70% ethanol and deposited in the echinoderm collection of the Paulo Young Invertebrate Collection (UFPB/ECH), Department of Systematics and Ecology, Federal University of Paraíba, Brazil.

***Astrocyclus caecilia* (Lütken, 1856) (Figure 1)**

This specimen has a pentagonal disk, 30.04 mm in diameter (Figure 1a), covered by a thick skin, with white spots in the interradial areas and among the radial shields (Figure 1a and 1c). These spots correlate with groups of plate-shaped dermal ossicles. On the distal margin of dorsal interradial region of the disk, the plate-shaped dermal ossicles form three groups of spots, one central and rectangular or semicircular, and two lateral (Figure 1c). The radial shields are large

(approximately $\frac{1}{2}$ of the diameter of the disk), bar-like (Figure 1a and 1c), covered by granules that form rows of clear rings intercalated with darker areas (Figure 1c). These clear rings correspond to bigger granules, which have two rows of hooks (Figure 1c). Sometimes the clear rings of the distal portion of the radial shields are extended, contacting in the area among the radial shields. The dark bands are formed by contiguous granules of different sizes and forms, but smaller than those of the light bands (Figure 1c). There are five madreporites,

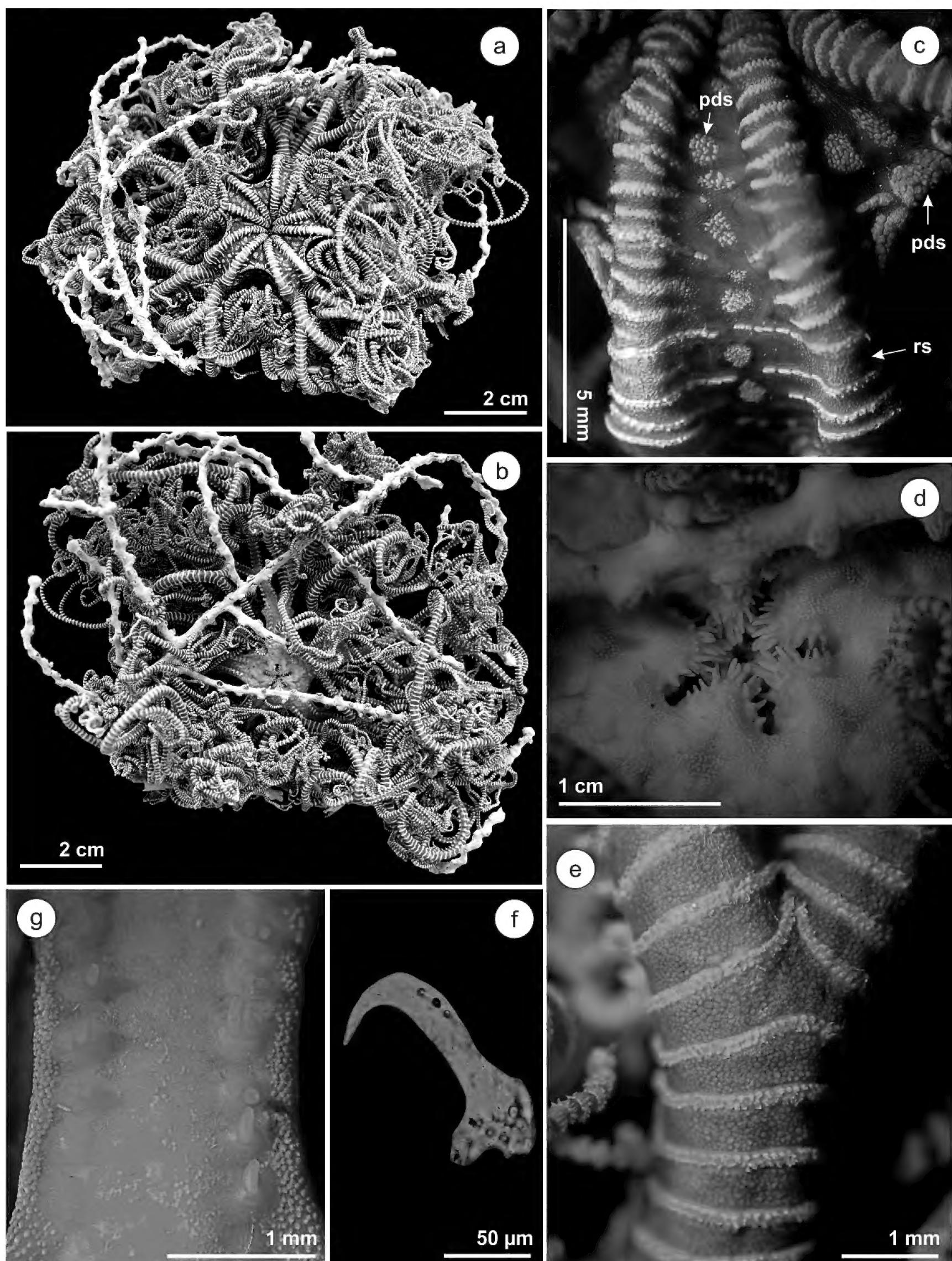


Figure 1. Main taxonomic characters of *Astrocyclus caecilia*. (a) Dorsal view of disk; (b) ventral view of disk; (c) detail of radial shield; (d) detail of jaw; (e) dorsal view of arm; (f) microscopic hooks (optical microscopic image); (g) ventral view of arm.

slightly rectangular and located near the jaw. The genital slits are short and broad, located laterally to the first bifurcation of the arm. The ventral interradial region is covered by a thick skin and sparse granules (Figure 1d). The disk is thickened by a hump at the juncture of the disk and the base of each arm. This hump-like appearance is due to bar-like radial shields.

There are five branched arms (Figure 1a and 1b). The dorsal and lateral surfaces of the arms are annulated (Figure 1a and 1e), with inflated, white and transverse rows of hooklet-bearing plates. The areas between the rows of hooklet-bearing plates are depressed and brown in color. Each hooklet-bearing plate has two rows of numerous microscopic hooklets (Figure 1e) that have one longer terminal tooth (Figure 1f). The ventral region of the arms and the jaw is covered by skin and granules. Spines are absent from the first two arm segments. One small and conical arm spine is observed on the third arm segment. From the fourth arm segment onwards, there are three small, conical arm spines, which decrease in size from the ventral to the dorsal spine. There is a crown of up to four hyaline denticles at the end of each arm spine.

Astrocyclus caecilia is recorded from the Bahamas Islands, Florida, Mexico, and the Caribbean Sea (Cuba and Barbados) (Hernández-Herrejón et al. 2008; Alvarado and Solís-Marín 2013). In Brazil, this species was only known from the states of São Paulo and Rio Grande do Sul (Tommasi 1970). The record in this study is the first for northeastern Brazil. This species occurs from 5 to 677 m in depth (Tommasi 1970; Laguarda-Figueras et al. 2009). The present material was collected at a depth of 130 m, associated to the gorgonian *Scleracis guadalupensis* (Duchassaing & Michelotti, 1860).

The examined specimen was brownish. However, color in this species varies from reddish brown to cream-colored. Hernández-Herrejón et al. (2008) and Laguarda-Figueras et al. (2009) reported 9 arm bifurcations in specimens of *A. caecilia* with a disk diameter of 13 mm. Tommasi (1970) reported 15 bifurcations in a specimen with a disk diameter of 26.5 mm. Unfortunately, it was not possible to record the total number of arm ramifications in this study. *Astrocyclus caecilia* may be distinguished from the remaining species of Gorgonocephalidae that occur along the Brazilian littoral by the presence of five madreporites.

MATERIAL EXAMINED: UFPB.ECH.2161, 1 specimen; Diogo Lopes, Macau, Rio Grande do Norte State, Brazil, 04°47'56.4" S, 036°27'33.5" W; depth, 130 m; 12 December 2011.

***Astrophyton muricatum* (Lamarck, 1816) (Figure 2)**

Disk pentagonal, dd = 50.18 mm, uniformly covered by small granules (Figure 2a and 2d). Radial shields long (approximately $\frac{1}{2}$ of dd), bar-like, with one or two distal spines (Figure 2a, 2c and 2e). Ventral surface and jaw uniformly covered by granules, similarly to dorsal surface (Figure 2h). Oral papillae and teeth are spiniform (Figure 2h). Slightly cordiform madreporite (Figure 2b). Genital slits short and large, located laterally to first branch of arm.

There are five branched arms (Figure 2c and 2d), uniformly covered by granules similar to those on disk (Figure 2f). First arm branch beginning on margin of disk (Figure 2a and 2c). First arm segments (before second branch) without spines or tentacle pores. Two arm spines occur, beginning on third arm branch. Towards the extremity of the arm, the number

of arm spines increases to three and then four. Arm spines small, in the shape of cat claws (Figure 2g and 2i). Tentacle pores small and placed laterally. Distalmost arm branch with rings of hooks on dorsal surface.

Astrophyton muricatum is recorded for the Bahamas, North Carolina, Florida Keys, Gulf of Mexico, Caribbean Sea (Guatemala, Honduras, Nicaragua, Costa Rica, Cuba, Haiti, Dominican Republic, Puerto Rico, Virgin Islands, Jamaica, Barbados, Belize, and Curaçao), Panama, Colombia, and Venezuela (Hernández-Herrejón et al. 2008; Solís-Marín et al. 2013). In Brazil, this species is known for the states of Pará, Ceará, Bahia (Lima-Verde 1969; Tommasi 1970), and Vitória-Trindade seamount chain (Tommasi and Aron 1987). The present study establishes the first record of *A. muricatum* for the state of Rio Grande do Norte. This species may be found from 0 to 508 m in depth (Hernández-Herrejón et al. 2008), but is most common between 2 and 70 m (Benavides-Serrato et al. 2011).

According to Hendler et al. (1995), juvenile specimens (with less than 1.5 mm in disk diameter) with relative few arm branches are pink, while the color of large individuals are homogeneously black, brown, light chocolate brown, yellowish brown, bright orange-yellow, gray, or dirty-white. Specimens studied herein were brownish. Tommasi (1970) reported from 1 to 4 spines per radial shield in specimens from Lixa Reef (Abrolhos, Bahia, Brazil). According to Tommasi (1970), these spines had an irregular distribution, being found either on distal or on proximal regions. Specimens examined in this study had only 2 spines, always located on distal extremity of radial shield (Figure 2e). The juvenile specimen (dd = 20.38 mm) had arms with 11 ramifications. Unfortunately it was not possible to verify the number of bifurcations in the larger specimen (dd = 50.18 mm), because it was damaged and the arms were broken (Figure 2a and 2b). *Astrophyton muricatum* differs from the remaining Brazilian species of Gorgonocephalidae by the presence of 1 to 4 spines on each radial shield.

MATERIAL EXAMINED: UFPB.ECH.2036, 2 specimens; Diogo Lopes, Macau, Rio Grande do Norte, Brazil, 04°42'09.9" S, 036°28'08.2" W; depth, 120–130 m; 18 August 2011.

During the 10 years, new records of 20 ophiuroids were recorded from Brazilian waters (Ventura et al. 2006; Borges and Amaral 2007; Barboza et al. 2010; Campos et al. 2010; Gondim et al. 2010, 2011, 2012; Manso et al. 2011, 2014). Two of these records were from relatively shallow waters down to 35 m, six records were below 50 m, and twelve from depths greater than 200 m.

The species recorded in this study were previously known from Brazil, but from very scattered locations. *Astrocyclus caecilia* was previously recorded in southeastern and southern Brazil. The present record in the northeastern fills a gap on species distribution, and suggests that it occurs along the entire Brazilian coast, nevertheless not yet recorded in locations where deeper depths were little explored by previous researches. The same may be suggested for *Astrophyton muricatum*, which was previously recorded for Pará, Ceará, and Bahia. The present record of this species for Rio Grande do Norte fills a gap in our knowledge of the distribution of this species in northeastern Brazil.

Recently, the species *Asteroporpa (A.) annulata* and the family Hemieuryalidae Verrill, 1899 were recorded for Brazil

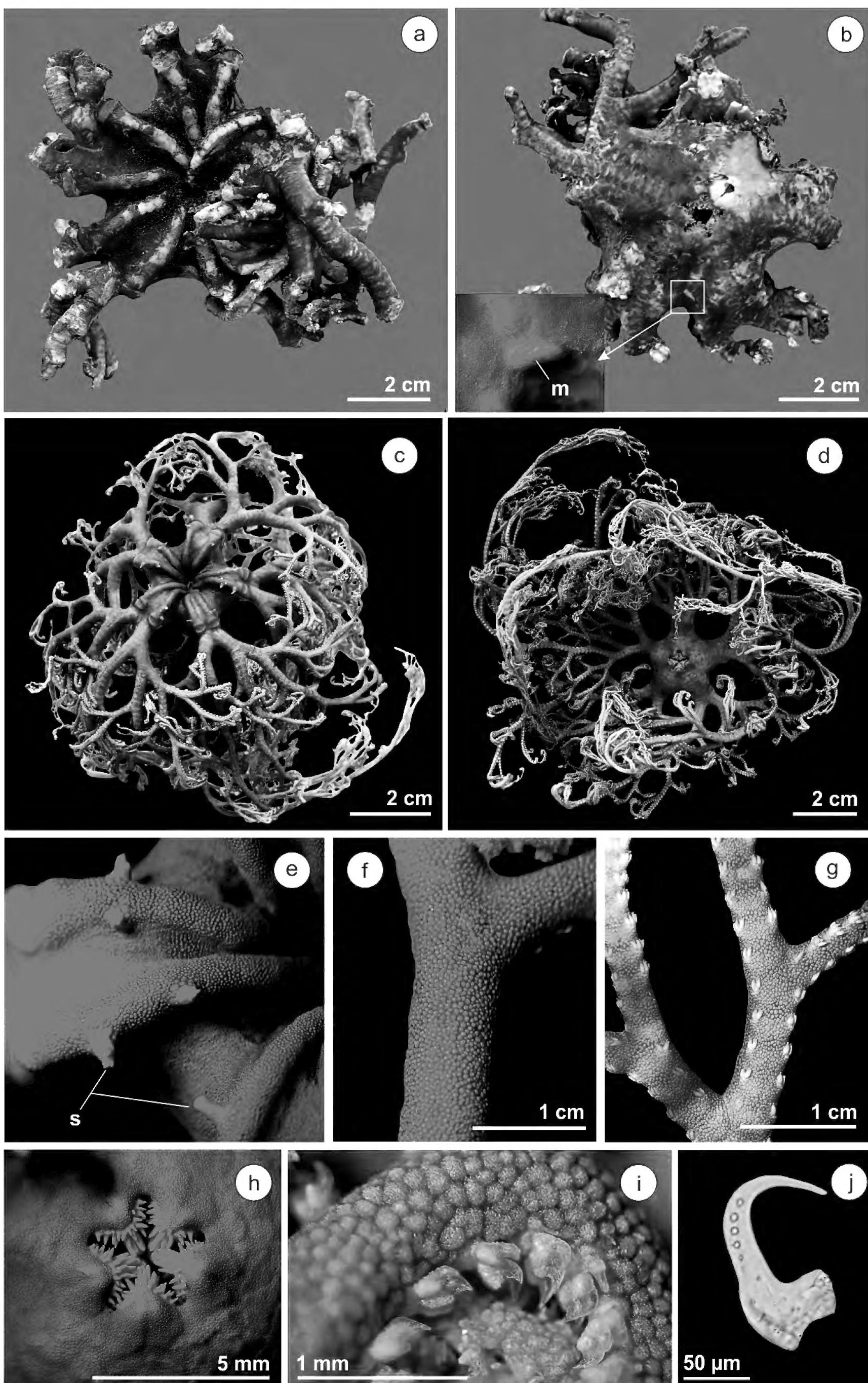


Figure 2. Main taxonomic characters of *Astrophyton muricatum*. (a) Dorsal view of disk in adult specimen; (b) ventral view of disk in adult specimen, madreporite in detail; (c) dorsal view of young specimen; (d) oral view of young specimen; (e) detail of radial shield; (f) dorsal view of arm; (g) ventral view of arm; (h) detail of jaw; (i) detail of arm spines; (j) microscopic hooks (optical microscopic image).

on the basis of specimens collected accidentally by a fisherman using a fishing-line and hook (Gondim *et al.* 2011, 2012). The new accidental collections reported herein point to interesting interactions between researchers (taxonomists) and the population that directly explores natural resources (*e.g.*, fishermen). This type of interaction contributes to the discovery of new species and to the obtainment of new locality records, helping us to increase our knowledge of the marine fauna from the outer continental shelf.

The species of Gorgonocephalidae recorded in the present study are distributed from Bahamas to the southern Brazil, showing that both species are capable of transposing the Amazon River barrier or that their patterns of distribution pattern may result from an older biogeographical barrier. Stampar *et al.* (2012) proposed two possible scenarios for the speciation of the genus *Isarachnanthus* Carlgren, 1924 (*I. maderensis*, *I. nocturnus* and *I. bandanensis*) (Ceriantharia) in the Atlantic Ocean, one of which suggest the possible existence of an internal sea connection in the middle of the South American continent during the Late Miocene. For several other animal groups, the Amazon River has been shown to do not hinder the interchange of species between the Brazilian coast and Caribbean Sea (*e.g.* Lazoski *et al.* 2001; Garcia *et al.* 2007; Floeter *et al.* 2008; Stampar *et al.* 2012; Petuch 2013).

At least 60% of the species of Ophiuroidea recorded for the Brazilian littoral also occur in the Caribbean. According to Collette and Rützler (1977), below depths of 50 m, sponges and gorgonians can function as “stepping stones”, providing habitat for reef fish species, linking the Caribbean and Brazilian faunas. Considering that *A. muricatum* and *A. caecilia* inhabit biological substrata, the presence of these “stepping stones” may favor the dispersion of these species. Unfortunately their modes of larval development are unknown. Thus, more biogeographical and studies in population genetics are necessary to understand the connectivity existing between these populations.

ACKNOWLEDGMENTS

This paper is dedicated to the fisherman Luis Ferreira Damasceno (Belo), who during his profession collected little-known marine specimens from the Brazilian coast and kindly donated these rare specimens for research. AIG was supported by CAPES (Coordenação de Pessoal de Nível Superior, Brazilian Ministry of Education) through a Ph.D. scholarship. MLC was supported by a CNPq productivity research grant (Process number: 300198/2010-8). We wish to express our sincere gratitude to two reviewers for their critical reading of the manuscript and constructive comments.

LITERATURE CITED

Alvarado, J.J. and F.A. Solís-Marín. 2013. *Echinoderm Research and Diversity in Latin America*. Berlin/Heidelberg: Springer. 658 pp.

Baker, A.N. 1980. Euryalinid Ophiuroidea (Echinodermata) from Australia, New Zealand, and the south-west Pacific Ocean. *New Zealand Journal of Zoology* 7: 11–83 (doi: 10.1080/03014223.1980.10423763).

Barboza, C.A.M., F.M. Mendes, A. Dalben, and L.R. Tommasi. 2010. Echinodermata, Ophiuroidea, *Gorgonocephalus* Leach, 1815: First report of the genus for the Brazilian continental margin. *Check List* 6(2): 289–291 (<http://www.checklist.org.br/getpdf?NGDo18-10>).

Benavides Serrato M., G.H. Borrero-Pérez and C.M. Dias Sanchez. 2011. Equinodermos del Caribe colombiano I: Crinoidea, Asteroidea y Ophiuroidea. *Serie de Publicaciones Especiales de Invemar* 22: 384 pp.

Borges, M. and A.C.Z. Amaral. 2007. Ophiuroidea (Echinodermata): quatro novas ocorrências para o Brasil. *Revista Brasileira de Zoologia* 24(4): 855–864 (doi: 10.1590/S0101-81752007000400001).

Campos, L.S., C.A.M. Barboza, P.F. Alcântara, R.B. Moura, R. Frensel and P. Wanderley. 2010. Echinodermata; pp. 235–292, in: H.P. Lavrado and A.C.S. Brasil (eds.). *Biodiversidade da região oceânica profunda da Bacia de Campos: megafauna e ictio-fauna demersal*. SAG Serv, Rio de Janeiro.

Collette, B.B. and K. Rützler. 1977. Reef fishes over sponge bottoms off the mouth of the Amazon River. *Proceedings of the Third International Coral Reef Symposium Miami, Florida* 305–310.

Floeter, S.R., L.A. Rocha, D.R. Robertson, J.C. Joyeux, W.F. Smith-Vaniz, P. Wirtz, A.J. Edwards, J.P. Barreiros, C.E.L. Ferreira, J.L. Gasparini, A. Brito, J.M. Falcón, B.W. Bowen and G. Bernardi. 2008. Atlantic reef fish biogeography and evolution. *Journal of Biogeography* 35: 22–47. (doi: 10.1111/j.1365-2699.2007.01790.x).

García F.J., M. Domínguez and J.S. Troncoso. 2007. Biogeographic considerations of the Opisthobranchia (Mollusca: Gastropoda) fauna from the Brazilian littoral and nearby areas. *Bonner Zoologische Beiträge* 55(3/4): 203–222 (<http://biodiversitylibrary.org/page/44801601>).

Gondim, A.I., C. Alonso and C.L.C. Manso. 2010. First record of *Ophionereis dolabriformis* (Echinodermata: Ophiuroidea: Ophionereididae) for the Brazilian coast. *Marine Biodiversity Records* 3(e34): 1–4. (doi: 10.1017/S1755267210000096).

Gondim, A.I., T.L.P. Dias, C.L.C. Manso and S. Stöhr. 2011. An enigmatic species of Hemieuryalidae (Ophiuroidea: Ophiurida) from Brazil; p. 135, in: 1st Latin American Echinoderm Conference, Puerto Madryn, Argentina. 174 pp.

Gondim, A.I., T.L.P. Dias and C.L.C. Manso. 2012. Updated morphological description of *Asteroporpa* (*Asteroporpa*) *annulata* (Euryalida: Gorgonocephalidae) from the Brazilian coast, with notes on the geographic distribution of the subgenus. *Revista de Biología Marina y Oceanografía* 47(1): 141–146 (<http://www.revbiolmar.cl/resumenes/v471/471-141.pdf>).

Hernández-Herrejón, L.A., F.A. Solís-Marín and A. Laguarda-Figueras. 2008. Ofiuroideos (Echinodermata: Ophiuroidea) del Golfo de México. *Revista de Biología Tropical* 56 (Suppl. 3): 83–167 (<http://www.redalyc.org/articulo.oa?id=44919815005>).

Hendler, G., J.E. Miller, D.L. Pawson and P.M. Kier. 1995. *Sea Stars, Sea Urchins, and Allies: Echinoderms of Florida and the Caribbean*. Washington: Smithsonian Institution Press. 390 pp.

Laguarda-Figueras, A., L.A. Hernández-Herrejón, F.A. Solís-Marín and A. Durán-González. 2009. *Ofiuroideos del Caribe Mexicano y Golfo de México*. México. 249 pp.

Lazoski C., A.M. Solé, N. Boury-Esnault, M. Klautau and C.A.M. Russo. 2001. Cryptic speciation in a high gene flow scenario in the oviparous marine sponge *Chondrosia reniformis*. *Marine Biology* 139: 421–429. (doi: 10.1007/s002270100542).

Lima-Verde, J.S. 1969. Primeira contribuição ao inventário dos equinodermas do Nordeste Brasileiro. *Arquivos de Ciências do Mar* 9(1): 9–13.

Ljungman, A.V. 1867. Ophiuroidea viventia huc usque cōgnita enumerata. *Öfversigt af Kongelige Vetenskapsakademiens Forhandlingar Stockholm* 1866: 303–336 (<http://biodiversitylibrary.org/page/32287761>).

Manso, C.L.C., J.P. Oliveira and M.S. Ximenez. 2011. Echinodermata, Ophiomyxidae, *Ophioscolex glacialis* Müller & Troschel, 1842: first record of the species for the South Atlantic. *Check List* 7(3): 383–384 (<http://www.checklist.org.br/getpdf?NGDo32-11>).

Manso, C.L.C., A.I. Gondim and C.R.R. Ventura. 2014. New records of

Ophiuroidea (Echinodermata) of the Brazilian coast, with notes on its taxonomy and distribution. *Marine Biodiversity Records* 7(e124): 1–7. (doi: 10.1017/S1755267214001237).

Migotto, A.E. and C.G. Tiago. 1999. *Biodiversidade do Estado de São Paulo. Síntese do Conhecimento ao Final do Século XX. Vol 3. Invertebrados Marinhos.* São Paulo: Fundação de Amparo à Pesquisa do Estado de São Paulo. 310 pp.

Okanishi, M., T.D. O'Hara and T. Fujita. 2011. Molecular phylogeny of the order Euryalida (Echinodermata: Ophiuroidea), based on mitochondrial and nuclear ribosomal genes. *Molecular Phylogenetics and Evolution* 61(2001): 392–399. (doi: 10.1016/j.ympev.2011.07.003).

Petuch, E.J. 2013. *Biogeography and Biodiversity of Western Atlantic Mollusks.* Boca Raton, London, New York: CRC Press, Taylor & Francis Group. 227 pp.

Solís-Marín, F.A., J.J. Alvarado, M. Abreu-Pérez, O. Aguilera, J. Alió, J.J. Bacallado-Aránega, E. Barraza, M. Benavides-Serrato, F. Benítez-Villalobos, L. Betancourt-Fernández, M. Borges, M. Brandt, M.I. Brögger, G.H. Borrero-Pérez, B.E. Buitrón-Sánchez, L.S. Campos, J. Cantera, S. Clemente, M. Cohen-Renjifo, S. Coppard, L.V. Costa-Lotufo, R. del Valle-García, Y. Díaz, M.E. Díaz de Vivar, J.P. Díaz-Martínez, A. Durán-González, L. Epherra, M. Escolar, V. Francisco, C.A. Freire, E. García-Arrarás, D.G. Gil, P. Guarderas, V.F. Hadel, A. Hearn, J.C. Hernández, E.A. Hernández-Delgado, A. Herrera-Moreno, M.D. Herrero-Pérezrul, Y. Hooker, M.B.I. Honey-Escandón, C. Lodeiros, M. Luzuriaga, C.L.C. Manso, A. Martín, M.I. Martínez, S. Martínez, L. Moro-Abad, E. Mutschke, J.C. Navarro, R. Neira, N. Noriega, J.S. Palleiro-Nayar, A.F. Pérez, A. Pérez-Ruzafa, E. Prieto-Ríos, J. Reyes, R. Rodríguez, T. Rubilar, T. Sancho-Mejía, C. Sangil, J.R.M.C. Silva, J.I. Sonnenholzner, C.R. Ventura, A. Tablado, Y. Tavares, C.G. Tiago, F. Tuya and S.M. Williams. 2013. Appendix; pp. 543–654, in: J.J. Alvarado and F.A. Solís-Marín (eds.) *Echinoderm Research and Diversity in Latin America.* Berlin/Heidelberg: Springer.

Stampar, S.N., M.M. Maronna, M.J.A. Vermeij, F.L.d. Silveira and A.C. Morandini. 2012. Evolutionary diversification of banded tube-dwelling anemones (Cnidaria; Ceriantharia; Isarachnanthus) in the Atlantic Ocean. *PLoS ONE* 7(7): e41091. (doi: 10.1371/journal.pone.0041091).

Stöhr, S., T.D. O'Hara and B. Thuy. 2012. Global diversity of brittle stars (Echinodermata: Ophiuroidea). *PLoS ONE* 7(3): e31940. (doi: 10.1371/journal.pone.0031940).

Tommasi, L.R. 1970. Os ofiuróides recentes do Brasil e de regiões vizinhas. *Contribuições do Instituto Oceanográfico, Universidade de São Paulo Série Oceanografia Biológica* 20: 1–146.

Tommasi, L.R. and M.A. Aron. 1987. Equinodermes dos Bancos Submarinos da Cadeia de Montanhas Vitória-Trindade. *Relatório Interno do Instituto Oceanográfico da Universidade de São Paulo* 18: 1–9.

Ventura, C.R.R., R.P.N. Lima, C.C. Nobre, I. Veríssimo and P.C. Zama. 2006. Filo Echinodermata; pp. 339–389, in: Lavrado, H.P. and Ignacio, B.L. (eds). *Biodiversidade bentônica da região central da zona econômica exclusiva brasileira, Vol. 18.* Museu Nacional, Série Livros, Rio de Janeiro.

Verrill, A.E. 1899a. Report on the Ophiuroidea collected by the Bahama Expedition from the University of Iowa in 1893. *Bulletin from the Laboratories of Natural History of the State University of Iowa* 5: 1–86 (<http://biodiversitylibrary.org/page/38867354>).

Verrill, A.E. 1899b. VII. North American Ophiuroidea. I. Revision of certain families and genera of West Indian ophiurans. II. A faunal catalogue of the known species of West Indian ophiurans. *Transactions of the Connecticut Academy of Arts and Sciences* 10: 301–386 (<http://biodiversitylibrary.org/page/13457106>).

Authors' contribution statement: AIG, TLPD and MLC collected the data, analyzed the results and wrote the text.

Received: February 2014

Accepted: January 2015

Editorial responsibility: Sérgio Stampar